

Toxics in Fish

Toxic pollutants in our bays, rivers, and streams can show up in the fish that live there, causing them to become diseased and posing a health threat to us when we eat the fish. Pollutants in the Puget Sound ecosystem include several important classes of chemicals including, PCBs, PBDEs, PAHs, and Endocrine Disrupting Compounds.

Concern over these chemicals in Puget Sound is high because they are toxic, they last for a long time in the ecosystem, and their levels increase in predators as the chemicals move up the food chain, a process called biomagnification. Measuring these pollutants in fish tissues tells us whether present-day levels are harmful to the fish or the predators that consume them and whether they are safe for us to eat.

Scientists have been tracking contaminant levels in Puget Sound fish since 1989 and have established threshold limits for these chemicals in fish tissues. These thresholds give us a guideline for the level of toxic chemicals that fish can tolerate, before they become diseased or show other harmful effects.

Toxics in Fish

INDICATOR:

- 1) Levels of four types of toxic contaminants in several species of fish
- 2) Contaminant-related disease in fish

Indicator lead: Jim West, Washington Department of Fish and Wildlife

TARGET:

Target 1) By 2020, contaminant levels in fish will be below health effects thresholds (i.e. levels considered harmful to fish health, or harmful to the health of people who consume them)

Target 2) By 2020, contaminant-related disease or impairments in fish are reduced to background levels

Contaminant Type 1

Polychlorinated Biphenyls (PCBs)

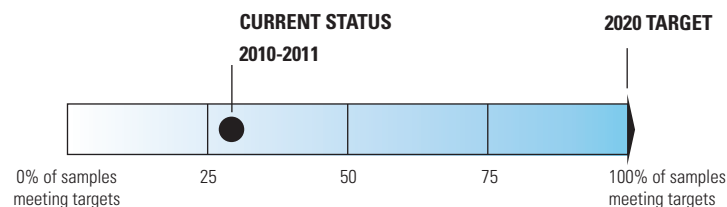
PROGRESS:

IS THE
TARGET MET?

NO

IS THERE
PROGRESS?

NO



PCBs exceeded health effects thresholds or have been identified as a risk to seafood consumers in recent years for (1) urban English sole, (2) adult Chinook salmon returning to Puget Sound rivers, (3) juvenile Chinook salmon in Puget Sound or its river mouths, and (4) Pacific herring in Southern and Central Puget Sound. There has been no significant decline in PCBs in these species for the period monitored. However, adult coho salmon returning to Puget Sound rivers were below thresholds.

Progress Towards 2020 Targets

Of the four classes of toxic chemicals being tracked and reported on, one (polybrominated diphenyl ethers) show signs of progress, two (polychlorinated biphenyls and polycyclic aromatic hydrocarbons) show no change, and for one of the four (endocrine disrupting chemicals) there is not enough information to determine if progress is being made. The full 2020 target language for toxics in fish that was adopted by the Leadership Council is complex, relating four different classes of chemical contaminants to three different types of fish (herring, English sole, and salmon/steelhead), with four different concentration thresholds that range from no adverse effects to

Contaminant Type 2

Flame Retardants (polybrominated diphenyls, or PBDEs)

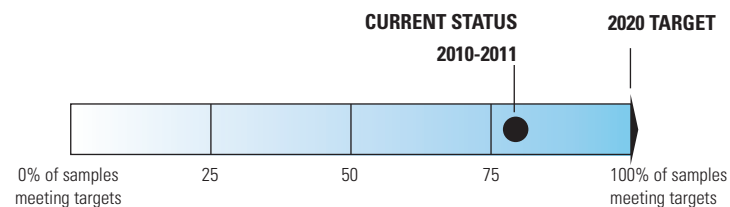
PROGRESS:

IS THE
TARGET MET?

NO

IS THERE
PROGRESS?

YES



Evaluation of PBDEs is challenging because health effects thresholds are not yet available for some species. However, it appears that in most species levels are at or below obvious, immediate concern for most areas. In addition, PBDE levels appear to be declining in Pacific herring from Central and Southern Puget Sound.

no toxics-related reproductive impairment.

Making progress towards 2020 targets requires identifying which chemicals are most problematic, and then controlling their sources or cleaning up pollutants that have accumulated in the environment.

The danger of some chemicals (such as PCBs) was identified, and source controls imposed, over thirty years ago. PCB levels in Puget Sound fish today are probably ten times lower than they were in the 1970s, but they have not changed appreciably in the past 20 years. Current PCB levels are high enough to trigger Department of Health consumption advisories for Chinook salmon and other species, and are probably still high enough to harm fish health. Further reduction of PCBs in the ecosystem will likely require a combination of activities, including cleaning up contaminated sediments, identifying and halting new sources of PCBs into the system, and waiting for

existing PCBs in the system to degrade or become unavailable.

Some progress towards 2020 targets for PBDEs has been made. The danger of flame retardants (polybrominated diphenyl ethers, or PBDEs) was recognized relatively recently, and source controls have been imposed. These include a legislated ban on the use of certain PBDE compounds and voluntary reduction in production of other compounds by industry. Although it is unclear whether these actions were responsible, PBDEs have been declining in one monitored species, Pacific herring, from Central and Southern Puget Sound, to levels that are likely below cause for concern.

Progress related to hydrocarbons (polycyclic aromatic hydrocarbons, or PAHs) has been mixed. This is probably related to the huge range of sources for these compounds (they come from petroleum, and from burning fossil fuels), and the difficulty in controlling such pervasive sources. Some

Contaminant Type 3

Hydrocarbons (products of petroleum or combustion; polycyclic aromatic hydrocarbons, or PAHs)

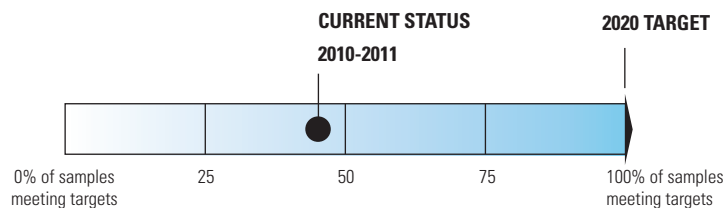
PROGRESS:

IS THE
TARGET MET?

NO

IS THERE
PROGRESS?

NO



PAHs are tracked in fish by measuring byproducts (metabolites) of the compounds in their body fluids (in Pacific herring), or by measuring liver disease caused by PAH exposure (in English sole). PAHs levels in herring, a water-column species, from Central and Southern Puget Sound are similar to those of some urban English sole, a bottom-dwelling species. PAH levels in both species from these areas are cause for some concern. However PAH-related liver disease has declined to near background levels in one urban area (Elliott Bay).

Contaminant Type 4

Endocrine Disrupting Compounds (typically from pharmaceuticals, personal care products, but also from a wide range of other chemicals)

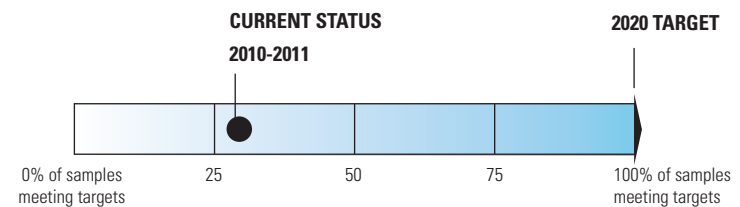
PROGRESS:

IS THE
TARGET MET?

NO

IS THERE
PROGRESS?

UNKNOWN



Endocrine disrupting compounds (EDCs) are chemicals that alter the normal hormonal system of fish, often resulting in problems related to growth or reproduction. EDCs have been evaluated in two species, English sole (adults) and Chinook salmon (juveniles). EDC-related feminization of male English sole was observed at five of six sampled locations, and in juvenile Chinook salmon from three of four sampled locations.

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effects of PAHs in the ecosystem may be significant but are currently not monitored. Of the effects represented by this indicator, we have seen a dramatic decline in PAH-related liver disease from prevalence rates of over 30% to less than 10% in English sole from Elliott Bay, one of Puget Sound's most highly contaminated bays. The reason for this recovery is unclear, but could be related to sediment cleanup, removal of creosote-treated pilings, or control of new inputs to the bay.

Not enough monitoring has been conducted yet to fully evaluate progress towards the target of reducing Endocrine Disrupting Compounds (EDCs). These chemicals originate from a huge range of sources including pharmaceuticals, personal care products, plastics, other industrial, agricultural or household products, and some of the chemicals described above. EDC effects were observed in fish, primarily as a trend towards feminization of males, in most places where English sole and juvenile salmon were sampled. Only one status survey has been conducted for these species so far. Unlike the pollutants above, EDC effects have been observed in fish from waters surrounded by rural areas. Many of these chemicals can be introduced to aquatic systems via wastewater.

What are These Indicators?

Indicators

Each of the Toxics in Fish indicator metrics begins with a measure of the degree to which fish are exposed to toxic contaminants. In most

cases this means measuring the chemicals in fish tissues, in the form of "tissue residues". In some cases fish systems can break down or metabolize the chemicals, in which case the pollutants don't accumulate in their bodies. In these cases chemists measure "metabolites" of the chemicals, usually in the bile or blood of the fish.

In order to understand the potential harm these chemicals may cause, these metrics also incorporate an understanding of the "health effects threshold" of each chemical for each species. This is the level of contamination an individual can tolerate before it experiences some health effect. The combination of knowing what contaminant levels the fish is exposed to with its tolerance for a chemical provides a guide for selecting recovery targets.

In some cases it is easier to measure contaminant-induced disease or other health impairment directly. Examples of these metrics in the Toxics in Fish Indicator are PAH-related liver disease and EDC-related reproductive impairment in English sole. In these cases it is possible to observe recovery of fish health directly, after exposure to the contaminant is removed from the fish's habitat.

The Contaminant Monitoring Program

The Washington Department of Fish and Wildlife monitors toxic contaminants in fish and other organisms, as a member of the Puget Sound Ecosystem Monitoring Program (PSEMP). This program has tracked the indicator metrics described above for several species in the

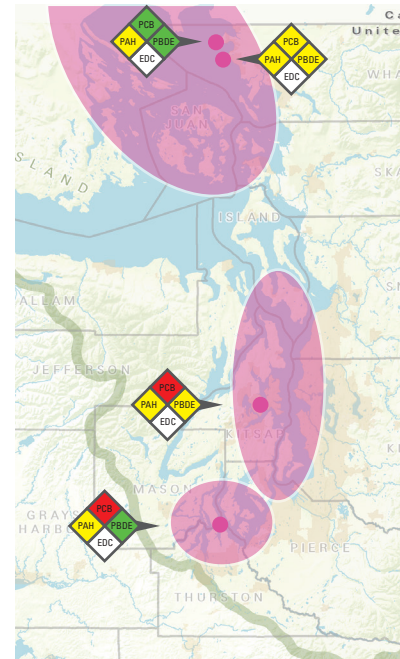
ecosystem, in addition to a number of chemicals not covered here. In addition, the PSEMP Toxics in Fish Unit has conducted a number of focus and diagnostic studies, along with partners including NOAA Fisheries, to develop new markers and investigate contaminants in the food web.

Interpretation of Data

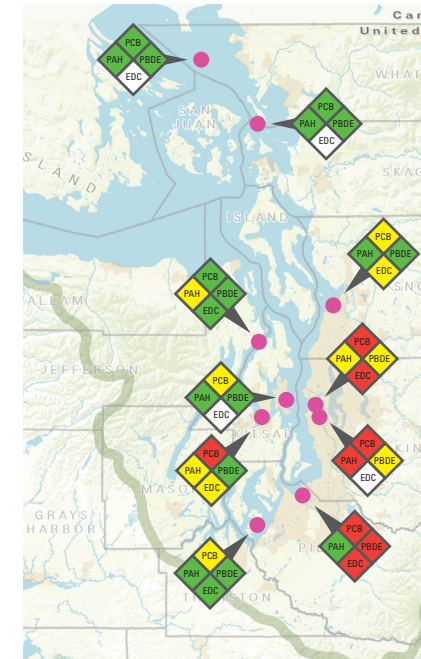
The Indicator metrics provided in this summary simplify a highly complex relationship between exposure of organisms to pollutants, and the effects such exposure might have on their health. Toxic contaminants in Puget Sound are found in fish throughout the ecosystem – not just in urban areas, and not just in bottom-dwelling fish. In addition, many contaminants accumulate in fish as they age. Some of these “bioaccumulative” contaminants also move up the food chain, increasing to high concentrations in apex predators. It is important to interpret data with reference to where the fish live, where they were sampled, their age, and their position in Puget Sound’s food web.



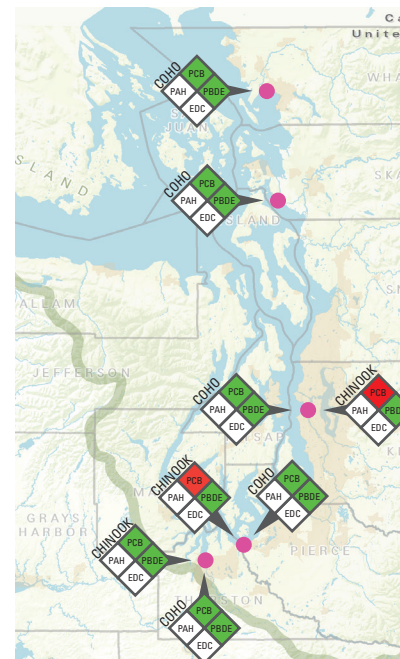
Pacific Herring



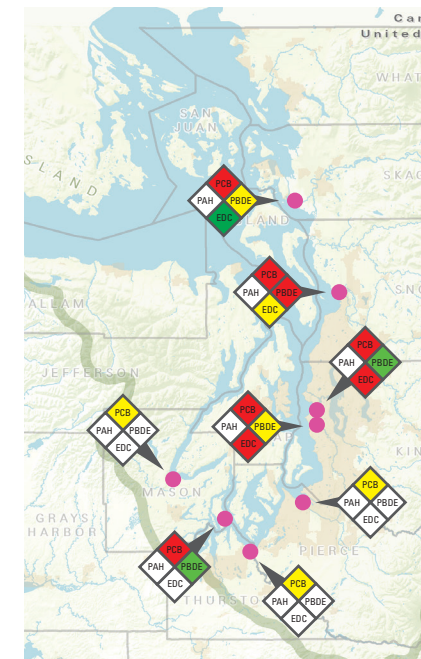
English Sole



Adult Chinook and Coho Salmon



Juvenile Chinook Salmon



Climate Change and Its Impact on the Status of the Ecosystem

Puget Sound is especially vulnerable to climate change, which has already affected its environment, economy, and communities. Without action, climate change will negatively affect nearly every part of Washington's economy through changes in temperature, sea level, and water availability.

Climate change pressures in Puget Sound include changes in stream flow timing and volume, air and water temperature, loss of snow-fed water supplies, sea level rise, and ocean acidification. These pressures could have serious consequences for human health, including reduced water supply, losses to agriculture and forest industries, losses of fish and wildlife, impaired functioning of natural systems, and increased frequency, and intensity of extreme weather event such as droughts, floods, heat waves, wildfires, and heavy rain and snow storms. Other impacts to natural resources and Puget Sound communities will vary, but these are not as readily predictable.

Puget Sound climate is also affected by large-scale patterns of natural variability, particularly the El Niño/Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO). While it is not clear at this time how climate change will affect the frequency or intensity of ENSO or PDO, we should expect continued year-to-year and decade-to-decade variability in regional conditions even as the long-term mean around which we vary is affected by climate change.

Adapting to our changing climate means understanding how climate change could affect priority recovery issues and using that knowledge to take steps that will reduce or avoid the negative impacts of climate change. Although we should seize opportunities that exist now, adaptation is part of long-term risk management, not a one-time effort. Decision-makers must consider the impacts of climate change when funding and prioritizing restoration projects.

Climate change affects more than just the weather and the seasons. Climate patterns play a fundamental role in shaping natural ecosystems

as well as the human economies and cultures that depend on them. Because so many systems are tied to climate, a change in climate can affect many related aspects of where and how people, plants, and animals live, including food production, availability and use of water, and health risks. For example, a change in the usual timing of rains or temperatures can affect when plants bloom and set fruit, when insects hatch or when streams are their fullest. This can affect historically synchronized pollination of crops, food for migrating birds, spawning of fish, water supplies for drinking and irrigation, forest health, and more.

Climate Change and the 2012 Action Agenda

To ensure that the 2012 Action Agenda is consistent with state strategies and actions for responding to climate change, its approximately 250 strategies, sub-strategies, and actions were reviewed to determine their degree of climate sensitivity. Roughly half reflected observed and predicted changes in climate or aligned to the state's climate response strategy. Based on this review, achieving our long-term goal of Puget Sound ecosystem

What are climate change and global warming?

Global warming refers to the recent and ongoing rise in global average temperature near Earth's surface. It is caused mostly by increasing concentrations of greenhouse gases in the atmosphere. Global warming is causing climate patterns to change. However, global warming itself represents only one aspect of climate change.

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer.

Source: EPA

recovery requires consideration of the relevance of climate change to strategies and actions beyond the 2020 time horizon of the Action Agenda.

The Department of Ecology recently released *Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy* (April 2012). Adaptation steps reduce the vulnerability of human and natural systems, increase the capacity to withstand or cope with changes in climate, and transform the system to be compatible with likely future conditions. Many adaptation strategies are considered win-win strategies because they address existing stresses on communities, economy, and environment while also helping reduce climate-related risks.

State climate response strategies and actions were integrated into the 2012 Action Agenda. Each strategy or sub-strategy of the Action Agenda includes a description of climate change impacts and related state strategies. Where possible, a climate change adaptation step was included in Near Term Actions. Climate change next steps are included in the future opportunities and emerging issues for each strategy section.

Fully integrating climate change into the Action Agenda will require looking at the implications of a changing climate beyond 2020. This will entail revisiting and possibly adjusting our definitions of a healthy Puget Sound, how we measure and evaluate progress, our use of value terms such as priority, ecologically important, sensitive, and high value. This also means that we will continually design and adjust policies, plans and tools so they account for a changing and variable climate.

This year and next, the Puget Sound Partnership and the Puget Sound Institute are working with the University of Washington's Climate Impacts Group to synthesize and update a growing body of climate change science. This new information will become part of the Puget Sound Science Review in the Encyclopedia of Puget Sound.

How Climate Change Guidance Is Applied to Near Term Actions

The degree of climate sensitivity for each Near Term Action was evaluated based on the following questions:

- Do proposed restoration projects take into account observed or likely changes in climate? If not, is it possible to do so?
- Given the likelihood of climate change, will a proposed project provide even some recovery benefits?

Can the Near Term Action meet its objectives "as is" given its sensitivity to climate?

While the act of preparing the criteria described in this Near Term Action is not sensitive to climate, the criteria may be inadequate if they do not consider how climate change may affect target habitats.

Suggested adjustments for implementation:

Example: 2008 Action Agenda Near Term Action A.1.2

Near Term Action A.1.2: Prepare a set of criteria to guide decisions for acquiring and protecting high-value, high-risk habitat.

Is the Near Term Action sensitive to changes in climate?

Yes. Habitat type, quality, and distribution may be affected by changes in temperature, precipitation, salinity, sea level, and other climate-related factors. Therefore, climate change may affect what is currently defined as "high-value, high-risk habitat."

1. climate change should be considered when designating "high risk habitat"
2. the criteria should include an assessment of how climate change is anticipated to affect habitat being evaluated.

Climate Changes

- ☑ **Changes in streamflow timing and volume:** Watersheds with streamflow based mostly or partially on snowmelt are projected to have the greatest hydrological shifts associated with climate change. Impacts to streamflow include earlier peak streamflows, decreasing runoff in late spring and summer, and increasing runoff in fall and winter.
- ☑ **Temperature changes:** Despite natural climate variability between years and decades, average annual and seasonal temperature is expected to continue to increase over the coming century. Most models project an enhanced seasonal precipitation cycle with wetter winters and drier summers.
- ☑ **Loss of snowpack and glacial retreat:** The loss of snowpack and glacial retreat are one of the most far-reaching impacts of rising temperature, affecting water availability for both people and wildlife. Under a moderate warming scenario, average spring snowpack in Washington State is projected to decrease 29% by the 2020s.
- ☑ **Sea Level Rise:** Global sea level is rising due to ocean thermal expansion and melting of land-based ice sheets. A medium estimate of sea level rise in the Puget Sound region is +6 inches (range of 3 to 22 inches) by 2050. Major impacts associated with sea level rise are likely to be inundation of low-lying areas, flooding, erosion, and infrastructure damage, with the largest impacts occurring when storm and river flooding events converge with high tides. Shifts in or loss of coastal habitat types is another major concern associated with sea level rise.
- ☑ **Ocean Acidification:** As the global ocean absorbs atmospheric carbon dioxide, these increasing concentrations are reducing ocean pH and carbonate ion concentrations, resulting in ocean acidification. Impacts of ocean acidification include altered marine food web, loss of shellfish production, and impacts to the growing environment for sea grasses like eelgrass.

Consequences of Climate Change

- ☑ **Severe impacts and risks to human health** from increased injuries and disease due to higher temperatures, heat waves, declining urban air quality, and smoke from more frequent wildfires. More frequent extreme storms are likely to cause river and coastal flooding that could lead to increased injuries and loss of life.
- ☑ **Increased damage costs and disruptions to communities,** transportation systems, and other infrastructure. Damage to roads, bridges, ports, rail, power, and communication transmission systems, and communities due to extreme storms, flooding, erosion, landslides, sea level rise, and storm surges could occur. In Puget Sound counties, structures valued at \$29 billion are located in flood hazard areas. Ports, rail, highways, wastewater treatment plans, and other infrastructure could require retrofits or relocation to accommodate rising sea levels and stronger coastal storms.
- ☑ **Reduced summer water supply.** Increasing temperatures will significantly reduce snowpack in the Cascade and Olympic Mountains. This will lead to reduced summer streamflows, reduced soil moisture, higher summer stream temperatures, and an increased risk of drought for Washington's water users, including agriculture, municipalities, and fish and wildlife. Increased water demand could increase the potential for conflict among users.
- ☑ **Loss of fish, wildlife, and natural systems.** Species will be forced to move northward or higher in elevation, and some will perish. Higher summer stream temperatures and reduced flows are projected to increase lethal stream conditions for salmon and other coldwater species. Increased forest fires will destroy habitat, leading to erosion and degraded water quality. Sea level rise is projected to eliminate valuable habitat, and increasing ocean acidity and upland runoff threatens shellfish aquaculture.
- ☑ **Losses to agriculture and forest industries.** Increased disease, pests, weeds, and fire, along with reduced summer water supplies, are already affecting Washington's farms and forests. Crops and yields are also likely to be impacted.